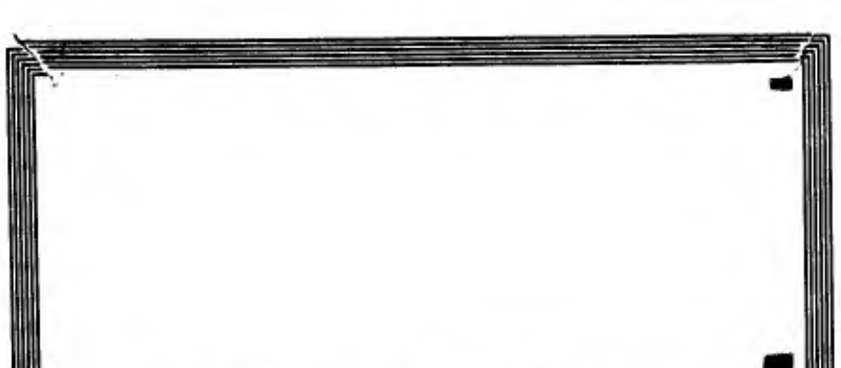

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HISTORICAL ANALYSIS OF WARTIME REPLACEMENT REQUIREMENTS; EXPERIENCE FOR SELECTED MAJOR ITEMS OF COMBAT EQUIPMENT

26 July 1966
(Volume I)

HISTORICAL EVALUATION AND RESEARCH ORGANIZATION
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The findings in this report are
not to be construed as an official
Department of the Army position
unless so designated by other
authorized documents.

HISTORICAL ANALYSIS OF WARTIME REPLACEMENT REQUIREMENTS: EXPERIENCE FOR SELECTED MAJOR ITEMS OF COMBAT EQUIPMENT

A Report prepared for the Research Analysis Corporation
under Subcontract FY 66-ARO1-1,
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Historical Evaluation and Research Organization
2233 Wisconsin Avenue, N. W.
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SUMMARY

The collection and organization of equipment loss data from US Army records for World Wars I and II and Korea provided the analytical base for this report. Records were neither uniform or complete, but the body of information extracted from them justifies the drawing of a number of useful conclusions and has made possible the quantification in standard terms of equipment losses in various combat postures under varying conditions.

During the course of the project HERO has furnished RAC a large quantity of intermediate and associate material. Such items are therefore not included here. Enclosures to this report include the following items: (1) A set of spread sheets based primarily on the reports submitted by units. These sheets show losses per 1,000/man-day and per 100 casualties, as well as actual numbers. They are presented by posture, chronologically, insofar as the reporting cycle and the nature of operations permitted; (2) A set of consolidations by posture, aggregating the loss experience of divisions and armies; (3) A set of bar graphs which present graphically the loss rates for each item of equipment by posture and in terms of both 1,000/man-day and 100 casualty factors; (4) A series of narratives to assist in defining the nature of the combat reflected in the numerical statements; and (5) A series of comparative documents which establish loss rates for four armies by man-day and casualty factors, a comparison of loss densities between two armies, mean values for divisions and armies overall and in various postures, and mathematical formulae for predicting materiel losses.

It was not possible to establish a continuous relationship between personnel casualties and equipment losses. There is, however, a clear relationship between casualties and the "intensity of combat" which is not apparent in any other way of measuring. This has produced a numerical scale of values--the Intensity of Combat Index (ICI)--which can be related to historical description and, given certain known factors, used as a predictive device.

Historical and professional military analysis reveals that there is indeed consistency in the nature of combat losses. Significant variations are explicable in terms that have great

relevance to the conditions prevailing when the loss was incurred. Extensive analysis has produced an organization and explication of the material that permit the user to select that body of codified experience best fitted to the type of conflict he wishes to examine. The reduction of data to the common basis of items lost per 1,000/man-days of combat permits the free comparison of experience over a wide range of cases and the isolation of extreme and mean cases for use in constructing loss-rate formulae.

The actual nature of the combat loss reporting system and the state of the records produce the conclusion that confidence in the reliability of data for planning purposes increases in direct proportion to the time span and size of unit. The long-term averaging of the experience of armies has produced loss-rate factors which can be related with considerable confidence to the circumstances under which the several armies operated. These circumstances, in turn, are described in such manner that they can be equated with the general nature of future combat, bearing in mind that the historical values find their greatest use in dealing with the scale, rather than the exact values of future losses. It is obvious that aggregation of data at the higher echelons of command and operations tends to dampen the effects of extreme cases. For procurement planning purposes this is probably beneficial, but the effect of extreme cases is displayed in both numerical and narrative form for use if required. This could be useful in war gaming at the tactical level; it also suggests criteria for the development of a supply system with the flexibility to lay down unusual amounts of equipment with great selectivity and speed in response to emergency situations.

The relative numerical weights of losses due to wearout and that due to enemy action in the total loss equation could not be determined from the data examined. The comparisons between armies does indicate that over time the wearout factor does increase significantly and the distances travelled by a large formation have steadily increasing effects on total losses. This matter is examined in some detail in the body of the report.

It became apparent as research and analysis progressed that the information being collected had uses beyond those of the current project. The further examination of the meaning of the Intensity of Combat Index in planning and forecasting appears promising. The search for influences having substantial effect on losses indicates the need for a sophisticated approach that combines the techniques of the professional military approach, historical examination, and mathematical analysis. Deep research into the reports

of maintenance and supply units at the higher echelons would also be helpful in supporting the construction of complex loss models as now envisaged by RAC.

In addition to the consideration of a number of influences affecting losses in general terms, most of which are referred to above, there is in the report further discussion of the loss rates of specific items and the reasons therefor. The report also offers a number of observations which focus on the general problems and conditions of battlefield reporting and analysis of such reports. There is a natural difference in purpose between real time reports and the requirements for later historical research. A special solution is proposed, involving the placement in the field of a small, highly specialized team to gather data as it is generated by combat action.

As a general conclusion, it can be said that the effort that has produced this report has yielded a set of numerical factors which, applied judiciously and imaginatively, form a solid input to mathematical models which synthesize the battlefield of the future with that of the past. Of particular value is the establishment of meaningful links between the nature and circumstances of battle, on the one hand, and personnel casualties and equipment losses on the other.

PREFACE

This study, "Historical Analysis of Wartime Replacement Requirements; Experience for Selected Major Items of Combat Equipment," has been performed by the Historical Evaluation and Research Organization (HERO) for the Research Analysis Corporation (RAC), as a subcontract in support of a study (RAC 63.8) on Wartime Replacement Requirements for the logistic program of the US Army: Procurement of Equipment and Missiles, Army (PEMA).

Listed below are the participants in this study, including individuals who served in a review or consultant status:

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Henry E. Eccles -- Rear Admiral, USN, Ret.; Consultant, George Washington University Logistics Research Project; Special Consultant
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Riley Sunderland -- HERO Staff Associate

Coordination and surveillance of the professional effort in the study was performed by Col. A.M. Fraser, USMC, Ret., who was aided principally by two Assistant Study Coordinators: Mrs. Molly R. Mayo and Miss Linnea P. Raine.

Despite HERO's gratitude for the cooperation and contributions of the study participants, none of them, individually or collectively, should be held responsible for any portion of this report. As Executive Director of HERO, and as coeditor of this report with Colonel Fraser, the undersigned assumes primary responsibility for its contents.

T. N. Dupuy
Executive Director

Washington, D.C.
25 July, 1966

I. INTRODUCTION

The purpose of the study, as stated in HERO's original proposal was "to codify and analyze loss and replacement experience for certain selected items of major combat equipment in World War II (Europe and the Philippines), Korea, and Vietnam, to include comparisons of equipment loss rates and personnel casualties (in terms of 1,000 man/days). From this information a set of replacement requirement curves will be prepared. These will be carefully evaluated with respect to the actual conditions of combat. These curves will then permit comparison between past experience and future prospects."

After preliminary examination of available records, it was agreed that the Philippines would be dropped from the study. Since Okinawa represented a sustained period of intense combat with Japanese forces, without the exaggerating effect of losses incident to assault of heavily defended beaches, the Okinawa campaign was substituted for the Philippines. After the original proposal was submitted it was determined by RAC project staff members that Vietnam losses would not form part of the data base of this study and this element was dropped. As numerical information was organized and tested, it became apparent that the 1,000 man/day factor was suitable as a base for expressing the "time in combat--equipment loss" relationship, but was awkward when used to establish the "equipment loss--personnel casualty" ratio. It was therefore decided to state this relationship as losses per 100 casualties. Finally, it was found that bar graphs appeared to locate and define significant correlations and variations more clearly than did curves and for this reason the former are used in this report.

II. METHODOLOGY

Organization of Data

As originally discussed, it was planned to collect and analyze information on equipment losses and personnel casualties in selected units and to present the resulting ratios in the format described in the original proposal. This presentation is included in this report, but it will be seen that alternative methods may be more useful in analysis of the meaning of the material displayed. It was initially agreed that the 1,000 man/day and personnel casualty figures would be based on infantry divisions in order to avoid the dilution of loss ratios by factors based on the experience of combat support and support units in very large formations, since they were not usually heavily engaged in close combat. This method was used, but the large and important amount of information developed from the records and reports of the numbered armies has made it desirable to evaluate their experience in the same terms.

It was planned to select units for study in consideration both of their combat experience and general reputation. This was done with some small changes in the original list made necessary by the availability of the records. It will come as no surprise to any working military historian that the surviving collection of primary records--incomplete in the first instance due to the problems and purposes of battlefield reporting--has further suffered the ravages of time and changing disposal policies. Subject to the limitations thus imposed, and to those dictated by the total amount of time and funds available for research, the final list represents a good cross-section of experience though not as large for statistical purposes as would be ideal.

Units selected for examination were:

World War I	77th Division
World War II - Africa, Italy, Northwest Europe	First Army Fifth Army Seventh Army 1st Division 6th Armd Division 28th Division 45th Division
World War II - Okinawa	Tenth Army

World War II - Okinawa (continued)	7th Division
	96th Division
Korea	2d Division
	25th Division

This list represents the spread of typicality and geographic location to the degree the records permitted. Several hopeful lines of approach failed, simply because there was not enough information immediately available to lead to any useful conclusions in the time available. In particular, a strenuous effort was made to develop information on the losses of airborne divisions in World War II in the belief that their experience might have some significance to the operations of the new air-mobile division. The search yielded nothing of significance, due to lack of adequate records.

The format and nature of RAC war games were discussed, in the hope that real historical equivalents could be established for detailed study. The starting conditions of the war game scenarios and the nature and duration of combat situations played made any large-scale correlation with historical experience difficult. Further, as will be discussed later, the actual reports of single units for short periods tend to induce wide variations in losses recorded and to reduce confidence in loss ratios derived from them. Some figures related to short periods of combat for smaller formations are contained in this report and could be used to determine upper and lower limits in ratios for single engagements, but their wide variations do not recommend their use as long-term planning factors.

From the RAC list of PEMA items being studied in the primary project, RAC and HERO representatives developed a list of items used in World War II and Korea whose battlefield density and positioning were comparable. The HERO search was to be directed to these specific pieces of equipment. This method was followed as closely as possible. It became apparent as the record search progressed that all items were not reported with the same frequency or accuracy. When the amount of information was insufficient to form any reasonable or reliable basis for study and conclusions, the item in question was not included. The resulting list of items presents a good general picture of a division's zone from front to rear and with respect to important mobile items within the area.

Certain consolidations were made in the interest of presenting a realistic picture of losses by type. This was done to aggregate the several types of medium tanks, 2½-ton trucks, and 30

caliber machine guns, in the interest of providing the best match for comparison with the future families of weapons. In one case--Fifth Army--this was also done with rifles caliber .30 1903 and rifles M-1. In this instance the 1903 rifle was the basic weapon for foreign troops in the Army and the consolidation gave an accurate representation of the basic weapon count. When 1903 rifles appeared only as special use weapons, they have been excluded from the computation, although figures have been listed in many of the enclosures.

Sources of Data

The primary sources of data for this study have been the actual records and reports of units, primarily G-4 and ordnance reports and working documents. When necessary to expand information or to seek better understanding of combat conditions, reference was made to unit histories and other secondary sources. The publications of the Office of the Chief of Military History were particularly valuable in gaining insights into the real nature of the battles studied.

The major portion of the basic research was done at the Federal Records Center, Alexandria. Some work was done in the National Archives. The Kansas City and St. Louis depositories furnished specific information upon request or, on occasion, confirmed that records were no longer available. Throughout the period devoted to record search the HERO staff received the very highest quality of understanding professional support from Mr. Wilbur Nigh of the FRC, and his staff.

Organization of Material

The matrix described in the original proposal has served to organize and guide the presentation of data throughout the project. It has become apparent that final presentation would require something somewhat more complex. The documents developed to present fully the information developed from the records include the following:

1. A set of "spread sheets" which, unit by unit, show the losses of those items for which reports were made. The sheets are organized by posture and express losses in terms of "per 1000 man/days" and "per 100 personnel casualties." It will be noted that the general tendency was to report at specified intervals rather

than in relationship to specific engagements. This served to make the association of losses with particular short periods of combat somewhat uncertain in many cases.

2. Consolidation of the spread sheets described above by posture. These consolidations in effect satisfy the requirements of the matrix.

3. A set of bar graphs which are organized to permit comparison of all the experience of a unit in a single posture with that of all other units. There are two sheets per posture for each item of equipment. One presents 1000 man/day factors and the other 100 personnel casualties factors.

4. A set of narratives designed to give the historian's view of aspects of the combat experience reflected in the loss figures given in the spread sheets. There has been no attempt to write complete historical accounts; rather, the effort has been restricted to an attempt to account for losses in terms of the conditions of combat, including such factors as terrain and weather, previous unit history, length of exposure, enemy tactics, and so forth.

5. A collection of comparative documents for analytical purposes, some of which suggest other ways of viewing and using the data available.

Correlations

Based on the material organized and presented as described above, the HERO professional staff proceeded to detailed search for the correlations that might exist, determination of the reliability of the factors produced at the several levels of aggregation, and development of logical general guidelines for the use of historical experience as an input to methods for estimating combat losses in future wars. The results of this work will be found in the next section of this report.

Assumptions

Some units provided for the reporting of "on hand" weapons and equipment and actual daily personnel strengths. In such cases these figures were used as appropriate. Many units, however, did not report in this fashion. In these cases, when beginning and end strengths over a period were given, a straight-line average

was used. In other cases, it was necessary to base computations on the Table of Organization and Equipment for the type unit involved. This latter method obviously has produced some man/day figures higher than those that probably obtained and thus reduced the "loss per 1000 man/day" factor. Similarly, when losses are expressed as percentage of T/E, there is some distortion resulting from the fact that the unit was not likely to be operating at full T/E strength for any extended period and battlefield density was thus reduced. It is equally true, however, that in some cases the reduced holdings required greater use of the assets in hand and resulted in greater exposure to enemy action and accelerated wear-out rates. This would appear to be particularly true of general purpose vehicles in emergency situations. It has been assumed that these factors tend to average out over time.

It will be noted in the spread sheets that there were many gaps between reporting periods and, even within a single period, not all losses seemed to be reported. In most such cases it has been assumed that the figures reported accurately represent the specific period and no attempt to fill in the blanks by extrapolation has been made. In some instances professional judgment (historical and military) has been applied to account for probable late reports and negative reports.

General Observations on Method

American forces tend to report personnel casualties promptly and accurately, so association of casualty figures with specific battlefield events proves to be relatively easy in most cases. This is not the case for equipment losses. The record leads to the strong supposition that commanders of fighting elements tended not to report the loss of items for which immediate replacement was not required. It is equally obvious from the record that it was not possible to make accurate inventories in the heat of battle. As a result, periods of rest or decreased activity following a major engagement produce reports of unusually large losses. This situation will be the subject of comment and recommendation later in this report.

It was necessary at times to select a single source of data from several covering the same period, since they did not always agree. The selection was based on the degree of involvement of reporting agencies and the level at which they were operating. Thus, ordnance reports were sometimes preferred over G-4 reports; Army-level reports were used rather than independent consolidations of subordinate element reports. This was a matter for

judgment on the part of the project staff. Secondary casualty data sources were used only when the actual reports of the units suffering the losses were not available. Nonbattle casualties were not included. It was necessary in the case of the 2d Division at Kunu-ri to make certain assumptions about the time at which losses actually occurred, since the conditions obtaining during the actual period of combat effectively prevented reporting on schedule. The lines of separation between events were so clear-cut that much confidence can be placed in validity of the resulting picture of a major unit under tremendous pressure.

Communications equipment has presented a special problem throughout. It was not possible to determine from field manuals in the 100 series or from Tables of Equipment what the allowances for the various types of unit were. Losses in most instances were reported with fair regularity and the results, when expressed as loss rates, do seem reasonable. In most cases, for example, the rates for the SCR 300, SCR 608, and SCR 610 appear to be directly proportional to their distribution and density over the battlefield. It was not possible, however, to determine what signal equipment casualties were attributable to enemy action, to accident, and to failure due to wear-out or climatic conditions.

A later section of this report will discuss a suggestion for obtaining more complete and accurate loss reports from operating commands. At this point it is desired only to point out that the wide variations in format, accuracy, completeness, and timing of reports encountered during the basic research phase of this project led to the conclusion that reliable data for planning purposes can be developed only by the examination of a number of samples. To the degree that available time permitted, this was done. The work is time-consuming and records do disappear and deteriorate. The significance and many potential uses of the information developed by the effort expended in this project suggest that serious consideration should be given to a much broader based project directed to the extraction and codification of much as yet unused information noted in the pursuit of this project, and additional information which can be located with more time for search.

III. CORRELATION AND CLASSIFICATION OF DATA

General

This section will compare and discuss the data produced by the method described in the preceding section. The principal effort will be directed to the determination of the degree of reliability and the applicability of the factors that have been developed, based primarily on the historian's analysis of events and conditions. It has become obvious to the HERO staff that the information made available by the basic research has uses and values far beyond the immediate requirements of the instant problem. Comment and recommendation will be offered at the end of this section.

Intensity of Conflict

In order to arrive at a basis for evaluation of equipment losses in terms of the pressures upon troops and commanders, it was believed essential first to develop a basis for determining the intensity of conflict. Since subjective judgment of the intensity of conflict is extremely unreliable (everyone who is under fire considers that the conflict is intense), the only objective basis for this determination appears to be in the casualty rate.

After comparison of the losses of divisions and armies within the various postures reported, a tentative numerical scale for comparing intensity of conflict was developed. This scale starts from the premise that the most intensive combat possible will cause 100% casualties per day, or 1 casualty per man-day. Thus the upper limit of the scale of intensity of conflict is automatically set at 100. On this scale, then, one casualty per two man-days would be 50, one casualty per three man-days would be 33.3333, one per 50 man-days would be 2.0, one per 100 man-days would be 1.0, one per 150 man-days would be .7667, etc.

Using this scale, and on the basis of the relatively limited number of units considered in this report, a somewhat arbitrary scale of intensity of conflict was established, as follows:

Armies

Overall (or mixed attack-defense)

Intense combat:	.167 or more
Moderate combat:	.166 to .100
Light combat:	.099 or less

Attack (if the general attack posture exists throughout the army; otherwise the overall, or mixed, scale should be applied)

Intense combat:	.250 or more
Moderate combat:	.249 to .167
Light combat:	.166 or less

Withdrawal

Intense combat:	.500 or more
Moderate combat:	.499 to .200
Light combat:	.199 or less

Defense (if the general defense posture exists throughout the army; otherwise the overall scale should be applied)

Intense combat:	.143 or more
Moderate combat:	.142 to .111
Light combat:	.110 or less

Divisions

Overall

Intense combat:	.250 or more
Moderate combat:	.249 to .133
Light combat:	.132 or less

Attack

Intense combat:	.500 or more
Moderate combat:	.499 to .200
Light combat:	.199 or less

Withdrawal

Intense combat:	2.000 or more
Moderate combat:	1.999 to .767
Light combat:	.766 or less

Defense

Intense combat:	.200 or more
Moderate combat:	.199 to .100
Light combat:	.099 or less

On the basis of this scale, it is now possible to discuss the intensity of the combat postures for every one of the formations for which data is presented in this report, as follows:

First Army (World War II, NW Europe)

Overall Intensity of Conflict Index (ICI): .197 - Intense combat.

Attack ICI: .173 - Moderate combat. This is misleading, however, since there was considerable defensive action by the Army from time to time between offensives, during which casualties were considerably less; thus the actual ICI for the attack and for the defense, if they were separable, would probably indicate intense combat.

Withdrawal ICI: .557 - Intense combat. This covers the eleven day crisis period of the Germans Ardennes offensive only. Although only a portion of the Army was actually in a withdrawal posture, this fact is considered in the development of the index.

Fifth Army (World War II, Italy)

Overall ICI: .117 - Moderate combat.

Attack ICI: .128 - Light combat. This is misleading for the same reasons as indicated for the First Army, above.

Seventh Army (World War II, NW Europe)

Overall ICI: .130 - Moderate combat. It is interesting to note that the intensity of combat of the Seventh Army is between that of the Fifth and First Armies.

Attack ICI: .128 - Light combat. Identical to that for the Fifth Army, and misleading and inapplicable for the same reason.

Withdrawal ICI: .267 - Moderate combat. This is consistent with the nature of the only significant withdrawal operation in which the Seventh Army was involved in January, 1945.

Defense ICI: .122 - Moderate combat. This is probably reasonably accurate, since the army as a whole was in a defensive posture during the limited period for which this data applies.

Tenth Army

Attack and Overall ICIs: .282 - Intense combat. This reflects a relatively short period of operations and combat could probably not have been maintained at this level of intensity for a prolonged period. The significance of this relatively high ICI, and the nature of the combat, becomes quite clear when compared with losses in supporting weapons and equipment. The Tenth Army was engaged in intense front-line combat against a tenacious enemy, which was relatively impotent, however, in long-range firepower (air and artillery). Thus it is likely (though this can be verified only from further research), that riflemen and automatic weapons crews had an even higher percentage of casualties with respect to supporting arms and services (principally artillery, armor, and engineers) than was the case in the other three armies.

1st Infantry Division

Incompleteness or elusiveness of equipment reports available for this division in the Federal Records Center at Alexandria made it impossible, in the time available, to make meaningful comparisons. The one instance used in the data presented herewith does not have casualty records which are comparable in the same time frame. (On the basis of First Army G-1 Reports for 1944-1945, the ICI of the division for 307 days was .353 - Intense combat.)

2nd Infantry Division (Korean War)

Withdrawal ICI: 5.270 - Intense combat. This is clearly a proper evaluation of the five-day ordeal of the division at Kunari.

6th Armored Division

Overall ICI: .200 - Moderate combat. This is consistent with the role played by this division: considerable time in reserve, with brief but intensive periods of action in the attack and, more briefly, defense postures.

7th Infantry Division (World War II, Okinawa)

Overall ICI: .581 - Intense combat.

Attack ICI: .663 - Intense combat.

25th Infantry Division (Korean War)

Overall ICI: .134 - Moderate-to-Light combat. This and the other indices are reflections of the extent of firepower superiority enjoyed by US forces when attacking in Korea.

Attack ICI: .169 - Light combat.

Defense ICI: .065 - Light combat. Also a reflection of firepower superiority.

Withdrawal ICI: .400 - Light combat.

28th Infantry Division (World War II, NW Europe)

Overall ICI: .617 - Intense combat (through 27 December, 1944, 151 days of combat).

Attack ICI: .797 - Intense combat.

Withdrawal ICI: 2.401 - Intense combat.

Defense ICI: .142 - Moderate combat

/On the basis of First Army G-1 Reports, this division was in SHAEF Reserve from 8 January to 18 March, 1945. From 18 March to 8 May, for 51 days, the ICI was .234 - Moderate combat. Overall, for 282 days, the ICI was .383 - Intense combat./7

45th Division (World War II, Italy)

Overall ICI: .239 - Moderate-to-heavy combat.

Attack ICI: .335 - Moderate combat.

Defense ICI: .637 - Intense combat. This reflects a period at Anzio in which the division was fighting for its life and was engaged in repeated counterattacks to secure the beachhead.

45th Division (World War II, NW Europe)

Overall ICI: .208 - Moderate combat.

Attack ICI: .408 - Moderate combat.

77th Division (World War I)

Attack ICI: .516 - Intense combat. This intensity is reflected even more clearly in the incomplete equipment loss records. It is clear from this small example of a division which was engaged less, and had a lower casualty rate, than some others, that the intensity of combat in World War I was in general far greater than that experienced in World War II. The reason for this is clearly the tremendous firepower capabilities resulting from static trench warfare, without the availability of mobility.*

96th Infantry Division (World War II, Okinawa)

Overall ICI: .551 - Intense combat. See the remarks for the Tenth Army, above.

Attack ICI: .579 - Intense combat.

Comparison of Army Equipment Loss Experience

General Observations

Perhaps the most notable thing about the Army data contained in the enclosures is the close correlation of the experience of the Fifth and Seventh Armies. This was particularly true of personnel losses, but the correlation is also quite close for all items of equipment for which there is a reasonable data base. Because of the similarity of personnel casualties, the equipment loss rates of these two armies compare very closely whether calculated with respect to 1000/man-days or 100 casualties. This is not true of the other armies, whose loss rates with respect to casualties were lower because of their higher casualty rates.

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*This is discussed at some length in HERO's report Historical Trends Related to Weapon Lethality, passim, but particularly Chapters Two and Six, and Appendix III. Another indication of the difference in intensity of conflict in World War I and World War II is the fact that during the first twenty days of operation Overlord, June 6-25, 1944, the British and American forces in Normandy suffered about the same number of casualties as was suffered by the British Fourth and Third Armies in one day--July 1, 1916.

Except for artillery and mortars (discussed below), the losses of the Seventh Army were slightly but quite consistently higher than those of the Fifth Army. From these facts it is obvious that there was considerable general similarity in the nature of the operations of the two armies, both of whom, for most of the time, were engaged in prolonged, slow-moving operations varying in intensity from moderate to heavy, against the defenses of a skillful and resourceful enemy. The higher rate of losses (with the exceptions noted) of the Seventh Army reflects the fact that for two periods for which data is included in the report, the Seventh Army was moving further and faster than the Fifth Army did. This obviously contributed to wearout loss rates, and to losses due to what may be called the social habits of the American soldier.

The First Army's loss rates, on the other hand, were consistently higher (with only one exception, 2½ ton trucks, discussed below) than those of the Fifth and Seventh Armies in all respects. A substantial proportion of this margin is clearly due to the very significant impact of the German Ardennes Offensive, but this merely is one of several aspects of First Army operations that generally covered more ground, were of greater variety in nature, and (overall) were somewhat more intensive, than those of the Fifth and Seventh Armies. This is logical, since the First Army was often making the main effort of the Allied or American forces in the principal theater of the war, and was more directly threatening the vital regions of the enemy's homeland.

There is considerably less consistency in the comparison of the Tenth Army with any of the other three. This reflects the fact, of course, not only that the operation was against a different kind of enemy, but also that it took place in a restricted region over a relatively short period of intensive combat, which probably could not have been sustained in a prolonged continental-type operation against the same kind of enemy. For these reasons the comparison of the operations of this army with those of the other three is less susceptible of generalization, but considerable significance can be found in the more detailed comparisons, below.

Vehicle Loss Rates

The loss rate of the Fifth Army was approximately six-sevenths that of the Seventh Army in both ¼ ton and 2½ ton vehicles. Because of the greater distances travelled by the Seventh Army (when considering operations just before the period considered which unquestionably contributed to the wearout rate), and because of the greater speed of the advance of the Seventh Army, it could have

been expected that this differential would have been greater. It was undoubtedly partly offset, however, by the longer period of time covered by the Fifth Army during the periods under consideration, and this time factor alone unquestionably contributed to wearout.

The ¼ ton loss rate for the First Army was slightly more than twice as great as that for the Fifth Army, and slightly less than twice that of the Seventh Army. This would be expected not only because of the considerably greater distance travelled by the First Army, but also by the nature of its operations, which undoubtedly caused greater local travel under combat and movement conditions than for the other two armies. This not only contributed to wearout, but undoubtedly resulted in more opportunities for German artillery fire against jeeps as targets of opportunity. Finally, the First Army loss rate was affected significantly by losses of several divisions, and two in particular, during the German Ardennes offensive. This is discussed in more detail below in connection with the vehicle losses of the 28th Division.

The First Army's loss rate in 2½ ton trucks, however, was only 90% as great as that of the Fifth Army, and 78% of that of the Seventh Army in relation to the 1000/man-day factor, and about 50% of those loss rates with respect to casualties. The considerations noted above for the ¼ ton trucks (save for targets of opportunity) should reasonably apply equally to the 2½ ton trucks, and one could even assume that round-trip average distances from supply points would have been greater for unit vehicles in the First Army than in either of the other two. There has not been time or opportunity to investigate this fact further. However, it is believed likely that Army Group and theater truck companies were operating more extensively and intensively along the First Army's line of communications than was the case for the other two armies.

Tenth Army ¼ ton loss rates were less than half those of the Seventh Army in relation to man-days, and about one-fifth those of the Seventh Army in comparison to casualties, with comparable relationships to loss rates of the First and Fifth Army on the basis of the comparisons previously noted above. The 2½ ton rates were even lower with respect to the European experience. Since the Seventh Army travelled 200 miles during the period of comparison (having just completed a movement of nearly 400 miles), the Fifth Army travelled about 300 miles during the period, and the First Army about 450 miles, while the Tenth Army moved a total of about 30 miles during three months, these differences are to be expected. Also contributing was the generally shorter distances from the front to primary local supply points on Okinawa.

Tank Loss Rates

As in most other items, the Seventh Army's tank loss rates slightly exceeded that of the Fifth Army, in this instance in the ratio of about 4:3. The First Army's loss rate was slightly more than twice that of the Fifth Army, and slightly less than twice that of the Seventh with respect to man-days, and less than 10% higher than that of the Seventh Army with respect to casualties. The reasons for this are clearly the same as those indicated above under General Observations, and in the discussion of ¼ ton loss rates under Vehicles, with particular emphasis on the impact of the Ardennes Offensive. First Army loss rates in tanks were only slightly higher than the other two armies in the attack posture.

The Tenth Army loss rate was slightly less than 90% of those of the Seventh Army with respect to man-days, and less than 50% with respect to casualties. There is really little or no basis for seeking a correlation, since tanks were used entirely differently on Okinawa than they were in Northwest Europe. On Okinawa they were almost exclusively used as infantry support weapons the assault of fortifications. The Japanese concentrated on targets since they represented a deadly menace to the type of defense they had installed. The losses suffered were almost entirely from mines and from Japanese anti-tank fire, whereas a substantial proportion of the losses in Europe were in fast-moving engagements with German tanks.

Automatic Weapon Loss Rates

In both machine guns and BAR's the previous relationship of loss rates of the Fifth and Seventh Armies was consistent. The First Army had a BAR loss rate about half again as large as that of the Fifth and Seventh Armies with respect to man-days, but (because of its higher casualty rate) only about 5% higher with respect to casualties. In machine guns the First Army loss rate was almost twice that of the Fifth and Seventh Armies, and 20% higher with respect to casualties. The factors noted under General Observations appear to apply here.

In the Tenth Army the loss rate for BARs was unaccountably nearly three times as great as that of the Fifth and Seventh Armies with respect to man-days, and--despite its high personnel casualty rate--nearly half again as great with respect to casualties. In machine guns, on the other hand, the Tenth Army loss rate was about half that of the Fifth and Seventh Armies and one-quarter that of the First Army with respect to man-days, and about one-quarter of

the rates of the Fifth and Seventh Armies and less than one-fifth that of the First Army with respect to casualties. These variations cannot be accounted for on the basis of the normal environmental factors we have been considering, including the intensity of the infantry battle, but apparently are explicable, at least in part, by the differing doctrines of Marine and Army units in the Tenth Army, and will be disucssed in this context later.

Rifle Loss Rates

At first glance the rifle and carbine loss rates for armies appear to be hopelessly inconsistent. In the First Army the loss of rifles alone was about 14% of total personnel casualties, rifles and carbines combined about 24%. Losses per 1000/man-days were .464. In the Seventh Army, loss of rifles was about 29% of casualties; rifles and carbines together were about 45% of casualties. Losses per 1000/man-days were .596. In the Fifth Army, rifles* losses were 17% of casualties, and rifles and carbines were 22% of casualties. Losses per 1000/man-days were .261. In the Tenth Army rifle losses were 4% of casualties; rifles and carbines together were slightly less than 9% of casualties. Losses per man-day were .242.

Although it has not been verified, there is reason to believe that the figures for the Seventh Army may include the replacement requirements for the First French Army. If so, and assuming that the losses were at least comparable in these two armies, this would suggest that in the Seventh Army alone, rifle losses were about 15% of casualties, and rifle and carbine losses together were about 23% of casualties. If that is the case, it provides a very close correlation between the First, Fifth and Seventh Armies in terms of relating rifle, and rifle and carbine, losses to personnel casualties. This would certainly be expected.

The discrepancy between these three armies and the Tenth Army may be explained in part by the fact that there was undoubtedly opportunity on Okinawa to salvage a much higher percentage of weapons abandoned on the battlefield than was the case in Europe. Secondly, there is probably a wearout factor, in the longer time periods involved in the European examples; this means that the loss per 1000/man-days has some slight relevance to the overall losses,

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*Both M-1 and Model 1903 losses were included in this one instance, on the assumption that non-US elements in the Fifth Army were equipped with the M-1903.

and there is a fairly close correlation between the 1000/man-day factors for the Fifth, Seventh (adjusted), and the Tenth Armies. The much higher loss per man-day factor of the First Army is almost entirely explicable in the very high losses suffered during the Ardennes Offensive. Some additional element may be found in the much longer distances covered by the First Army, with the consequent greater opportunity to lose individual equipment.

Artillery Loss Rates

Fifth Army losses in 105 mm howitzers were almost five times as great as the Seventh Army; its losses in 155 mm howitzers was about 3:2; overall light and medium artillery losses of the Fifth Army were 2.7 times as great as those of the Seventh. One contributing factor, perhaps, is the fact that the elapsed time period in the attack posture was more than twice as long for the Fifth Army as for the Seventh. The significance of this longer period of time is not readily discernable, however, unless the Fifth Army had a higher level of support of nondivisional light and medium artillery than did the Seventh. This is not ascertainable from the records on hand, although it can undoubtedly be determined. Another factor could be the amount of distance travelled over that period of time, although this, also, would be expected to have a greater impact on vehicles than on weapons. In any event, the Fifth Army travelled about 300 miles compared to slightly over 200 for the Seventh Army in the period under consideration.

The most important factor, however, was undoutedly the nature of the terrain in relationship to the nature of the combat. The Fifth Army operations were in more mountainous terrain, on a narrower front, where advance, and deployment of weapons, was limited to relatively few and well-defined defiles. The result was that German observation for counterbattery fire was rendered easier, and probably much more effective. Presumably this accounts for the difference in the losses. The reason why the 105 losses were so much greater proportionally than the 155 losses was probably simply a function of range, and thus of vulnerability to both observation and counterbattery fire.

First Army losses in 105 mm howitzers were almost ten times as great as those of the Seventh Army with respect to man-days, and almost nine times as great with respect to casualties; they were slightly more than twice as great as those of the Fifth Army with respect to man-days, and about half again as great with respect to casualties. First Army losses in 155 mm howitzers very closely approximate the loss rate of the Seventh Army, but are less

than a third those of the Fifth Army with respect to man-days and less than a fourth those of the Fifth Army with respect to casualties.

This leads to the suspicion that the loss reports of the Seventh Army with respect to 105 mm howitzers may have been in error, or that Seventh Army light artillery was exceptionally fortunate or skillful in avoiding German counterbattery fire. Otherwise, the relationship of loss rates of all three armies appear to be quite reasonable when special environmental conditions are considered, such as the exceptionally high loss rate of the Fifth Army in 155 mm howitzers being explained by the terrain factors mentioned above, which provided the Germans with an exceptional counterbattery capability.

The loss rate of the Tenth Army in 105s is quite comparable to that of the Fifth Army, in terms of man-days, but of course is less than half that with respect to casualties. In 155s the loss rate of the Tenth Army is less than half the rate of that of the lowest European army (Seventh). These rates are explicable in the light of the very poor Japanese counterbattery capability, which could inflict some damage on close support weapons, mainly because of the same kind of terrain advantage which the Germans had in Italy, but which was almost entirely frustrated by the greater range back to the American medium artillery.

Mortar Loss Rates

The comparison of mortar loss rates for the Fifth and Seventh Armies are almost exactly reversed from the usual relationship of loss rates between these armies. This is undoubtedly the result of the operation of the superior German counterbattery capability in Italy, as discussed above, under Artillery. The loss rate for the First Army is almost half again as large as that for the Fifth Army in terms of man-days, but is less than 90% of the Fifth Army rate in terms of casualties. The First Army has almost twice the loss rate of the Seventh Army in terms of man-days, but is only about 10% greater in terms of casualties. These relationships seem to be completely explicable in terms of the general factors operating to establish relatively high less rates for the First Army in comparison to the Fifth and Seventh.

Again the loss rates of the Tenth and Seventh Armies are quite close with respect to man-days, although the Tenth Army loss rate is less than half of that of the Seventh with respect to casualties. Apparently exactly the same factors were operating here as with respect to 105s, as discussed above.

Signal Equipment Loss Rates

There is no basis for comparison save in terms of Generating Units, M5. Here the normal pattern of the Fifth and Seventh Army was re-established, being very close to identical. Surprisingly the loss rates for the First Army would have been substantially smaller had it not been for the exceptionally high losses in December, 1944, obviously due to withdrawal in the face of the German Ardennes Offensive. This made the First Army loss rate rise to almost twice those of the other two armies.

Loss rates for the Tenth Army are relatively close to those of the First Army, not considering the Ardennes losses.

It is doubtful if any meaningful evaluation of these losses or the loss rates is possible. The actual numbers involved were not sufficient in any case to provide a truly reliable statistical sample.

Comparison of Division Equipment Loss Experience

General Observations

There are not enough divisions or enough extended samples of divisions in the various postures to be able to arrive at many important overall conclusions in terms of a general comparison of divisional equipment losses. Adding to the difficulties of comparison is the fact that the equipment losses by posture for the divisions in most cases, but to a varying degree, are not only often incomplete, but frequently misleading, since only the most immediately urgent losses were reported during an engagement, with the others reported during subsequent quiet periods, and after personnel deficiencies had been made up, permitting the division to handle the equipment replacements.

The special circumstances of the combat in Korea were such that the results are really not comparable with those of divisions during World War II and World War I. This is true not only because of the very great difference in the nature and quality of the opponent, but also because of the fact that combat equipment losses in the Korean War, at least during the early period of intensive operations, were affected to an abnormal degree by age and consequent excessive wearout. Thus the divisional equipment losses in Korea will be considered with respect to those of other divisions, in other conflicts, only where there appears to be real and direct relevance.

In general, somewhat more useful information will be provided by comparing loss rates of divisions within armies and within regions, and by comparing divisions to the general and posture loss rates of the armies under which they fought. These correlations will be discussed in the appropriate contexts later.

There are some general comments which have validity for the project, however.

First, the overall or total loss rates for the 28th Division are greatly affected by the exceptionally high losses during the withdrawal of the German Ardennes Offensive. They may also have been affected by the generally poor reputation of the division, which seems to have attracted considerable German interest and attention. Second, the loss rates for the 7th and 96th Divisions, on Okinawa, are very close to each other, with one or two notable exceptions.

Since the overall casualty loss rates of the two Okinawa divisions are quite close to those of the 28th Division, both for the attack, and overall, one would expect that there would be a fairly close correlation between their equipment loss rates. There is not. This provides one of the clearest demonstrations of one of the most important findings of this study: it is impossible to establish equipment loss rate factors based upon personnel casualties. It may also be a reflection of the German efforts to exploit the reputation of the 28th Division.

Vehicle Loss Rates

Vehicle loss rates varied considerably in Europe, and varied somewhat between the two divisions in Okinawa. However, the loss rates on Okinawa were consistently much smaller (with one relatively unimportant exception)on Okinawa than they were in Europe. One reason is the difference in distance travelled by all of the divisions in Europe--several hundred miles in each instance--with the distance travelled by the divisions in Okinawa--about 30 miles. This undoubtedly had a far greater wearout effect on ¼ ton vehicles than on the larger trucks, and this probably accounts for the fact that the divergency between vehicle loss rates in Europe and Okinawa is even greater for jeeps than for the 2½ ton trucks.

Other factors affecting the jeep loss rates were the differing natures of the terrain in Northwest Europe and Okinawa (although there was some similarity between Italy and Okinawa), and the differing capabilities of the respective enemies in artillery

fire. It is likely that a substantial percentage of jeeps lost in Europe were those of artillery forward observers, or reconnaissance vehicles of infantry and artillery which, under the circumstances, had to be used more aggressively in Europe than would have been possible or necessary on the more limited terrain of Okinawa. This is perhaps worth further investigation, though whether the records will reveal anything on this or not is doubtful.

Tank Loss Rates

Tank loss rates in Europe, for the units studied, and on the basis of a relatively small number of reports, were also much larger than those suffered by the two divisions on Okinawa. No significance seems to emerge from this other than has been mentioned above, under General Observations and under Vehicle Loss Rates. In light of the tank loss rate comparisons between armies this suggests that Marine tank losses were considerably higher than those of the Army units on Okinawa, thus suggesting that they used their tanks more aggressively, or with less caution, in the close support of assaults against fortifications.

Automatic Weapon Loss Rates

The above comments with respect to tanks apply in every respect to a comparison of automatic weapons losses, only more so, particularly with respect to very light relative losses in these weapons in the 7th Division (where reports may be incomplete) and the 96th Division. Again, we have a basis for investigating the fact that the Marines apparently had very much higher losses in automatic weapons than did the Army units on Okinawa.

Perhaps the most notable loss rates in automatic weapons were those of the 77th Division in World War I. Although the heavy machine guns were obviously more closely and cautiously controlled from higher headquarters than in World War II (consistent with the doctrine and organization during World War I), and although the equipment loss records are clearly incomplete, the loss rates of the 77th Division on the basis even of these incomplete figures were far greater than those of World War II with respect to 1000/man-days (approached only by the 28th Division), and also with respect to casualties, despite the heavy casualty rate of the division. This is simply further indication of the much greater intensity of conflict in World War I than in World War II.

Similarly, the far lighter intensity of conflict in Korea is again revealed by the automatic weapon figures, whether or not we

take into account the known high and excessive wearout rate for BARs, which undoubtedly affected the 25th Division's losses.

Rifle Loss Rates

Inspection of division-level reports in search of information of rifle losses reveals that some units simply did not report in this category. Among those who did, variations in loss ratios are so great as to make any confidence in them virtually impossible. There does appear to be an exception in the case of the 2nd Division at Kunu-ri. The extraordinarily high figures in this case can be rationalized as incident to the battle itself. A timely report and priority issue were urgently needed to re-equip a large number of men present for duty, but without a personal weapon. The incidence of loss of this magnitude as a factor in constructing requirements formulae cannot be given too much weight; rather, it seems to suggest the need for an "emergency--special delivery" component in the supply system.

The obvious differences between divisions, and the lack of any discernible correlation between losses reported by divisions and those reported by armies, lead to the conclusion that the rifle was handled as a piece of individual equipment which came and went with the man. The concern at the level of division and below seems to have been directed to maintenance of weapons in the hands of troops and the operation of a small maintenance float. Higher echelons, on the other hand, were obliged to recover weapons from men being evacuated, to handle battlefield salvage, and to equip replacements on their way forward to combat units. Net losses thus are likely to appear at higher echelons. It follows that long-term requirements for rifles lost in combat is probably based on the consolidated experience of armies, given some consideration of conditions peculiar to the unit under study.

The carbine, issued primarily to small unit leaders, weapons crews, and others who did not expect to participate in small-arms fire fights as a primary function, presents some of the same problems as the rifle. From time to time it was reported that the weapon was not popular with the troops and that many attempted to replace it with an unauthorized weapon--heavier or lighter as the experience of the individual indicated. There is no way to evaluate this factor. Since the carbine has been replaced, it would appear prudent to use requirements based on rifle data in all cases except where the pistol is now designated as the individual weapon.

Artillery Loss Rates

Two exceptionally heavy loss rates for artillery were encountered in the records: the 2nd Infantry Division at Kunu-ri--where the losses were catastrophic, yet not reflecting discredit upon the artillerymen, as indicated in Enclosure D-3--and the 1st Infantry Division at Gafsa and El Quettar, in Tunisia, in early 1943. The 2nd Division losses were due to the special withdrawal conditions which are discussed elsewhere in this report. Those of the 1st Division were in large part (and perhaps mainly; the records are not clear) due to enemy air attack, under conditions in which the Germans were still able to dispute air control with the Allies.

Otherwise, except for World War I experience, the losses were not sufficient in number to provide a good basis for statistical analysis. The heavy artillery losses of the 77th Division (and again almost certainly incomplete) are further evidence of the intensity of that conflict, and of the effectiveness of artillery emplaced behind stalemated trenches for prolonged periods.

Mortar Loss Rates

The loss rates of the 45th Division in Italy, the 28th Division in Northwest Europe (not counting the very heavy losses during the brief Ardennes Offensive) and the 96th Division on Okinawa were very close to each other in terms of 1000/man-days. The comparison is less close in terms of casualties because of the differing personnel casualty rates of these three divisions. This suggests that when opposed by a skillful and determined enemy, the loss rates in heavy mortars are more likely to be in proportion to the density of the weapons than to the casualty rates.

As would be expected, loss rates in Korea were much lower than those against Germans or Japanese in World War II. There are no comparable figures readily available for World War I.

Signal Equipment Loss Rates

The available signal equipment loss data for all divisions is most unreliable, and is so spotty and inconsistent as to defy analysis.

Comparisons in the Attack Posture

Vehicle Loss Rates

Bearing in mind the special conditions affecting the operations and losses of the different formations, as discussed earlier in this report, the World War II loss rates for vehicles in the attack posture are generally consistent between armies, between divisions, and between divisions and armies. In Europe the rate for jeeps per 1000/man-days varied among armies between .0317 (Fifth Army) to .0521 (First Army), and per 100 casualties between 2.492 and 3.0026, with the Seventh Army rates in between. The rate for jeeps among divisions varied from .0442 (28th Division) to .06603 (1st Division) and from .7981 (28th Division) to 1.4628 (45th Division, France). (The attack loss rates for the 6th Armored were probably somewhat higher than the highest indicated above for divisions, but no breakdown is available). The wider range between rates for divisions is explicable by the shortcomings of the reporting system, as discussed earlier. The losses of Tenth Army and of its divisions on Okinawa were about one-third to one-quarter of the European rates, for reasons fully explained earlier.

The variations among 2½ ton trucks are comparable to those for jeeps.

The rates of the 25th Division in Korea were much higher than those for World War II in Europe and many times higher than the rates on Okinawa. This is the result of two factors: (1) Excessively high actual losses, which seem to be largely attributable to extremely high wearout rates of old and poorly rebuilt equipment, and (2) Relatively low personnel casualties in low intensity conflict, which affected the loss rates per 100 casualties. This was almost equally true for both type of vehicle considered.

Tank Loss Rates

The factors affecting tank loss rates discussed under army and under division appear to apply to comparisons of the formations in attack posture. Again the Korean loss rates are unexpectedly high, presumably for the same reasons noted above under vehicles.

All Other Categories

No significant factors other than as already discussed.

Comparisons in the Defense Posture

General

In the light of the general initiative possessed by the Allies in World War II, the overall posture of most armies, most of the time, was offensive, even though some or most of an army's units might for several reasons be on the defensive or in a relatively inactive posture. Thus there is only one clearcut, and relatively brief period of defense among armies, in the Seventh Army. Although the major part of the First Army was in a defensive posture during mid-December, 1944, the special circumstances affecting several divisions were such that this has been included below in the Withdrawal posture.

Among divisions in World War II, there are only two among our sample for whom there is fairly good data with respect to the defense posture--the 28th and the 45th in Italy--although this divisional data is subject to the same qualifications as to completeness and accuracy as all other divisional equipment data. And the data for the 45th Division may be somewhat misleading, since the division was engaged in counterattacks during a considerable portion of the time it was playing a key role in the defense of Anzio Beachhead in February and March, 1944. There is also considerable data for the 25th Division in the defense posture in Korea.

Vehicle Loss Rates

In general the loss rate for vehicles in the defense with respect to the 1000 man/day factor was considerably less than for the attack. The loss rate with respect to casualties varied considerably, because of the great variations of personnel casualty rates among the units. The one exception to both of these generalizations was in the case of the 45th Division at Anzio, where the absolute loss of jeeps on the defensive was extremely high, thus more than offsetting the expected effect of the very high personnel casualty rate during that desperate period of defense.

The vehicle loss rates for the 25th Division in Korea were approximately as high,in terms of 100/man-days, on the defense as

they were on the offense, and much higher in terms of casualties because of their very low casualty rate in this posture.

Tank Loss Rates

Within the limits set by the paucity of data, the same factors seem to apply to tank loss rates in the defensive posture as for vehicles.

Automatic Weapon Loss Rates

The divisional figures for losses in the defensive posture are most questionable, since it was apparently during periods of relatively little movement, often while on the defense, when personnel replacements were received, and when divisions checked their equipment status and reported losses that had not been previously reported, but which had in fact occurred during the earlier attack posture. In general, however, the Seventh Army experience would seem to suggest that loss rates per 1000/man-days generally decline considerably during the defense, while loss rates per casualties do not change greatly, due to lower personnel casualties as well as lower equipment losses.

All Other Categories

No significant factors other than as already discussed.

Comparisons in the Withdrawal Posture

General Observations

While the available data for this posture has the same general shortcomings as for other postures, particularly among divisions, the fact that personnel casualties are generally substantially higher in a withdrawal than in any other posture, while equipment losses are very much higher, nonetheless shows up quite clearly. Data on the withdrawal posture is available for the First and Seventh Armies and 28th Division in World War II, and for the 2nd and 25th Divisions in Korea. An additional shortcoming in this data, so far as the armies are concerned, is the fact that a substantial portion of the army in each case was not withdrawing, but was on the defensive, while rather heavy losses were being suffered in those divisions and smaller units actually withdrawing.

Thus the army loss rate figures are considerably lower than they would be in the case of an entire army withdrawing under great pressure.

The data for the 2nd Division, and to a slightly lesser extent that for the 28th Division, and to a still less extent that for the First Army, are pertinent to situations in which something approaching a catastrophic withdrawal is carried out with considerable confusion and under great pressure, with high personnel losses, and even higher equipment loss rates. The data for the Seventh Army and for 25th Division, on the other hand, are examples of orderly withdrawal, under some pressure, but in delaying actions in which the withdrawing unit to a large extent controls the rate of its retirement. In comparing the loss rates of the two armies under these circumstances, the equipment losses per man-day vary from being three to ten times as great for the army withdrawing in confusion as that for the more orderly withdrawal. Because casualties are also greater in the confused withdrawal, the equipment loss rate with respect to casualties varies from nearly twice as high to six times as high in the confused withdrawal.

Withdrawal in Korea

The experience of the 2nd Division at Kunu-ri was unique in the Korean war and also in comparison to other divisions in other conflicts or theaters of war. The record as compiled for this study shows a consolidation of several periods of withdrawal by the 25th Division. For the purposes of this particular examination, that segment of its loss record for the period roughly coinciding with the six days covered in the 2nd Division's experience at Kunu-ri. These periods are 29 November to 5 December for the 25th, and 26-30 November for the 2nd Division.

The ratio of man-days in combat as compared here for the 25th compares with the 2nd as 3 to 2; on the other hand, 2nd Division casualties were to those of the 25th as nearly 8 to 1. The ICI for the 25th Division for that six-day period was .710; that of the 2nd Division was a very high 5.270. This comparison reveals the great difference in the intensity of the two experiences. Man-day factors when compared in equipment items reported by both divisions show an even greater spread. The total effect of comparing the factors produced by the 2nd Division record is one of such singularity that the rates of loss are not likely to be useful as a predictive device unless they are properly integrated into much larger total factors.

The extreme difference between casualty and man-day ratios also suggests that there is a point at which any straight line

relationship ceases--in other words, when casualties go past a certain percentage of total strength, equipment losses are accelerated disproportionately. This is not to disregard the effect of the withdrawal posture, involving the abandonment of equipment, as a major influence.

Withdrawal in Northwest Europe

Comparison of the withdrawal experience of the 28th Division over a five day period almost exactly six years earlier than that of the 25th Division cited above is most interesting, although not necessarily as illuminating as could be hoped for without opportunity for further research and evaluation. The ratio of man-days to combat is almost identical, 91 for the 28th Division compared to 99 for the 25th, or about 10 to 11, while the 28th Division casualties were considerably greater, about 5 to 2. The ICI of the 28th Division for that five day period was 1.852; less than one-third that of the 2nd Division in the period under consideration, but two-and-one-half times as great as that of the 25th Division in its similar period.

The equipment loss rates, for the most part, of the 28th Division were considerably less than those of the 25th Division in terms of man-days--with the large and significant exception of automatic weapons--and still further less in terms of casualties--again, save for automatic weapons, where the loss rates were close. This is largely due, of course, to the fact that while the 25th Division withdrawal was obviously well-controlled, it was a long and rapid retrograde movement, while that of the 28th Division was relatively short, and involved more intensive combat.

A comparison of the twelve day withdrawal experience of the 28th Division in the Battle of the Bulge with the previously considered withdrawal experiences of the 2nd and 25th Divisions in Korea provides some more interesting information. The ICI was 2.795, almost four times as great as that of the 25th, and more than half that of the 2nd at Kunu-ri. The equipment loss rates of the 28th were considerably less than those of the 2nd, but considerably higher than those of the 25th in 1000/man-days, and again particularly higher than the 25th in automatic weapons, while losses with respect to 100 casualties were substantially less in all items except automatic weapons, where they were greater.

The withdrawal experience of the 28th Division in comparison with the experiences of the First Army and the Seventh Army does not reveal anything of significance beyond what has been noted under General Observations, above.

Regional Comparisons

The Northwest Europe Experience

We have data on two armies and three divisions available for comparison: The First Army, which included the 28th Division; the Seventh Army, which included the 45th Division; and the 6th Armored Division (which was in the Third Army, for which we have not compiled data).

Comparison of the 28th Division with First Army. In the comparison of the 28th Division equipment losses with those of the First Army the results are generally what would be expected. During periods of relatively normal combat the Army as a whole would be expected to suffer somewhat higher overall combat losses, in percentage of TE, than would one division, particularly a division which, because of its reputation, would not normally be entrusted with a main effort in major offensive operations. Because, while one division--even the best--would alternate in the intensity of its involvement in combat, there was almost always at least one major operation going on within the Army's sector.

It is interesting to note, therefore, that in November, when for a while the 28th Division was making the only major offensive effort of the First Army, which led to its becoming the target of a major and effective German counteroffensive, losses of the 28th in general were far higher than those of the Army, on a percentage basis. This was true to a somewhat lesser extent in the Ardennes operation, where the 28th suffered heavily, but at least one division suffered far more severely, and several had at least comparable losses.

Comparison of 45th Division with Seventh Army. There is reason to suspect that the data compiled on equipment losses for the 45th Division during this two-and-a-half month period are incomplete. There is also some reason to believe (as indicated in an earlier section) that some of the losses indicated for the Seventh Army may have included replacements for the French First Army, although the close correlation of the Fifth and Seventh Armies further suggests that this equipment support (if there was any) for the First French Army may have been only in small arms weapons. However, without further search of the records, these questions with respect to this data do not permit any definitive conclusions to be drawn.

Comparisons of the Three Divisions: 28th, 45th, 6th Armored. The personnel casualties of the 28th Division were consistently higher than those of the other divisions; its overall ICI was a rather high .617; that of the 45th Division was .208, and that of the 6th Armored Division was .200.

Making allowances for the exceptional experience of the 28th Division in the Battle of the Bulge, there is a close correlation between the three divisions in both kinds of vehicles. The tank loss rate of the 6th Armored Division is understandably about four times as great as that of the 28th Division, and in fact greater if the Battle of the Bulge losses should be eliminated. There are no other data available for comparison of the 6th Armored with the other two divisions.

In all other categories of equipment the loss rates of the 28th and 45th Divisions are quite comparable (again allowing for the Bulge experience), with the rates of the 28th being somewhat higher, particularly with respect to man-days.

The Italian Experience

Prior to its participation in the landing in Southern France, the 45th Division was a part of the Fifth Army. It fought from Salerno north of Naples, and then fought all the way through the Anzio Campaign. With a few exceptions the loss rates of the 45th Division were substantially higher than those of the army in terms of 1000/man-days, but fairly close with respect to casualties.

The vehicle comparison is particularly interesting, to show how specialized experience can affect loss rates. The jeep loss rate of the division is almost twice as high as that of the army with respect to man-days, and about four-fifths that of the army with respect to casualties. In 2½ ton trucks, however, the loss rate of the division with respect to man-days is less than half that of the army, and the loss per 100 casualties less than one-fourth that of the army. The reasons are apparent. During most of the time after Salerno the division was operating in the mountains, and was being largely supplied by mule train. Its vehicle loss rates, both from enemy action and from wearout, were thus relatively low, particularly in 2½ ton trucks. During Anzio, the restricted beachhead kept the division from extensive use of 2½ ton trucks, and indeed there is reason to believe that it was at less than full strength in trucks during most of that campaign. However, jeeps were used as normally for liaison, reconnaissance, artillery forward observers, and the like. On the flat terrain jeeps became favorite targets of German 88mm guns, and this, presumably raised the combat loss rate.

The artillery loss rates per man-day are almost identical for the army and the division, although the army's rate with respect to casualties is about twice that of the division, in the light of its generally much lower casualty rate.

In automatic weapons and mortars the division's loss rates with respect to man-days were nearly three times as great as that of the army, although the loss rates per 100 casualties were much closer. For reasons discussed in the First Army-28th Division comparison, this kind of relationship in the heavily-consumed weapons is to be expected, since the division's rate is intensive for periods, and then less during rests, while the army's rate is continuous. In this case, obviously, the 45th Division had somewhat more than its share of these losses, but this is explained by the nature of its operations in the mountains in South Italy, and on the Anzio Beachhead.

The Okinawa Experience

A description of the circumstances under which Tenth Army fought will be found at Enclosure D-2. The natural conditions on Okinawa were not a major factor in overall loss rates and figures. It will be remembered that Tenth Army was made up of XXIV Corps (US Army) and III Amphibious Corps (Marines). The records examined were those of the 7th and 96th Divisions and the parent Army.

The correlation as between casualties in the two divisions was about 5:4, with the higher number occurring in the 96th Division, which was engaged longer. The ICI of the 7th Division was .581; that of the 96th was .551; nearly identical. The correlation between losses of trucks, ¼ ton, tanks, medium, and howitzers, 105 mm, is very nearly the same. In all other cases where comparison is possible, the 7th Division's losses were substantially lower. This discrepancy could be explained by incomplete loss records in the 7th Division, or by the fact that the 7th Division had profited more by its somewhat longer combat experience, or by the fact that the 96th Division was more effective. The answer is not clear from the records, although it undoubtedly could be at least partially revealed by further research.

The relationship between the losses of Tenth Army and 96th Division are significantly closer together, with a few notable exceptions. Losses in trucks, ¼ and 2½ ton, and in machine guns are quite close together in terms of the man-day factor. And in most other instances correlations were close in the casualty factor rate. The 96th lost just about its share of medium tanks on the basis of the casualty factor, considering that it was one of six divisions

operating, but its man-day factor stands half again as high, probably because of the averaging-down effect of some of the other divisions. The losses in Browning automatic rifles seems highly disproportionate, but it becomes understandable when it is known that the two Marine Divisions lost twice as many of these weapons as did the four Army Divisions present. The seemingly high loss in 81 mm mortars in the 96th Division as compared to those of the Army is not readily explained.

Mean Values for Equipment Losses

General

All of the World War II data collected and analyzed for this study has been further aggregated into two "Mean Value" tables, one for armies, and one for divisions. For the most part, the figures found in the research effort, and the rates and factors developed during evaluation, have been applied exactly as found and produced, and have been averaged to arrive at mean values. In some instances, as shown in each case by notes, data that was clearly misleading, or inaccurate, or untypical* has been omitted, or in instances where this could be justified by professional judgment, modified** to prevent distortion.

The resulting tables provide information that is interesting, and possibly valuable. These mean values and rates correlate reasonably closely with that data which we consider to be most reliable and most typical. These mean value tables, furthermore, particularly for armies, are internally consistent and reflect relationships between losses and rates which would be expected in equipment in typical operations for each of the three major postures: attack, defense, withdrawal, and for overall losses.

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*As the 45th Division's loss rates while on the defensive at Anzio, when in fact the division was for prolonged periods carrying the brunt of the VI Corps counterattack effort in order to retain the beachhead.

**Such as the rifle loss rates for the Seventh Army, or the 155mm howitzer losses under "other" postures which were almost certainly attributable to hostile counterbattery fire while a portion of the army was in a defensive posture.

Since there was only a single example from World War I, and only one presumably typical sample from the Korean War, the data base was considered insufficient to incorporate these into an overall mean value table for all formations considered in this study. It is believed that it would be useful at some future time to prepare mean value rates for both the Korean War and World War II, which could then be compared with the tables here presented. It would, furthermore, be desirable to provide greater confidence in the World War II tables, particularly in the division table of mean values, by developing additional data for several more divisions and at least two other armies (preferably the Third and the Sixth). A separate table for Marine Corps experience in the Pacific might also be valuable. It would also be desirable to prepare separate mean value tables for operations against the Germans and the Japanese, based upon more data, and compare these with each other as well as with a refined overall World War II table of mean values.

Army Table

The aggregations reflected in this table, and its overall close correlation with the experience of all four armies considered in this study, provide a basis for considerable confidence. On the other hand, the aggregation process tends to dampen the actual perturbations of extreme cases, thus introducing the possibility of some inapplicability to replacement requirements of small independent formations over relatively short periods of time.

Division Table

It is not possible to have as much confidence in this table as for that of the army experience. This is primarily due to the shortcomings of the equipment loss reporting system (or lack thereof) repeatedly noted throughout this report. Some of the specific results of these shortcomings are pointed out in the notes of the table, and are also reflected in several blank spaces.

On the other hand, despite greater unreliability in individual figures, this does indicate the nature of combat loss rate fluctuations more realistically than the Army charts, since the large support base of the army is excluded from the aggregations.

On the question of aggregation, there is one danger which must be avoided if and when divisional mean loss rate tables are prepared

from a broader statistical base. There will be a comparable (though lesser)dampening effect from aggregations in numbers and over time. Thus it will probably be desirable to prepare tables showing not only the means, but also the extremes (or at least the upper extreme), to permit building sufficient flexibility into the logistical system to assure reasonable readiness to meet unexpected demands.

Loss in Relation to Battlefield Density

It is clear that there is some relationship between equipment loss rates to battlefield density. Directly related to this, of course, is equipment vulnerability, but a reliable evaluation of the relation of losses to the density of equipment would presumably automatically reflect the effect of vulnerability. This was not a direct requirement of the study, but has been a matter of continuing concern, particularly in the evaluation process. It is obvious from changes and divergencies of Tables of Equipment and Tables of Authorization that this is not reflected with any degree of accuracy in applying the 1000/man-day factor.

There are, however, very serious difficulties in ascertaining even an approximate indication of battlefield density of equipment items. One of the most serious aspects of this is in the shortcomings of the reporting system, insofar as divisions are concerned. Density figures are meaningless unless it is possible to have a reasonable certainty as to when losses occurred in a given posture, and when they were replaced.

In the armies the reporting problem is slightly less significant because of the effects of aggregation already referred to, although this will, of course, have the already-noted dampening effect with respect to those postures and situations where losses tend to be high. But there is another problem in the armies which tends to reduce the value of straight density comparisons. The army T/As include not only combat units and combat support units, they include a wide variety of noncombat support units with widely varying compositions between theaters and between armies. Furthermore, the T/As include equipment in Army supply stocks, and the stockage level is not necessarily consistent between armies.

For the purposes of this study, however, we have prepared figures for two armies relating the losses by posture to the

quantities in the army's T/A. These are displayed in a single comparative chart, Enclosure E-2. This may provide some useful data for evaluation in the RAC study, or may suggest new approaches to this problem of density.

Aside from the caveats indicated above with respect to these density comparisons, there is some question as to the accuracy or reliability of the T/A figures for the First Army. This can, however, be checked and verified later, if this should be desired.

IV. CONCLUSIONS

Influences Affecting Losses

Intensity of Conflict

The measure of the "intensity of battle" appears to reside only in personnel casualties. No other significant measure was as stable.

The concept of an Index of Conflict Intensity (ICI) as developed in this study provides a useful tool for analysis of military operations for further research in the study of equipment replacement requirements. More data from combat experience should be surveyed and analyzed to refine the concept.

Enemy Capabilities

The quality and capabilities of the enemy force provide one of the most important imponderable factors affecting equipment loss rates.

There appears to be material for further investigation into the effect of the several tactical doctrines and bodies of technique encountered by American forces in recent times. For example, the distribution of casualties over the zone of action appears from early inspection to be quite different as between combat with Japanese and German forces. In the former case the forward infantry units appeared to absorb a higher percentage of total casualties and the rear was, as compared to that of units fighting Germans, reasonably safe. A detailed examination of this phenomenon could produce interesting material for evaluation of American tactical concepts.

The Influence of Terrain

Terrain becomes influential in combat to the degree that its uses are understood by sophisticated command and staff officers and acted upon by skilled troops. The Germans in Italy provide the most striking illustration of this concept. The informed use of the skill called "terrain appreciation"--the Napoleonic coup d'oeil --and the application of the principle of economy of force enabled the German forces to control defiles and to make maximum use of

superior observation. The result was a high price paid by Allied forces for their advances and controlled German withdrawals which avoided desperate "last stands" or entrapments. The value placed on "terrain" as a factor in predicting combat losses thus is a function of the enemy one contemplates fighting and the postures of the opponents.

The Influence of Time

While this project has not produced any numerical values for the influence of overall elapsed time on loss rates, it is obvious that such an influence does indeed exist in wearout rates. It is best to accept it as an organic element in the factor produced by experience over time, using factors based on (or considering) similar actual experience.

The Influence of Distance

All other things being equal, equipment loss rates of all or most items of equipment (not merely vehicles and tanks) are increased by wearout factors for distance covered in combat. The mathematical value of this factor has not yet been determined. It is possible that distance travelled, or expected to be travelled is a function of terrain and the opposing combat capabilities.

Specific Items

There is enough data provided by the study, including the mean value tables, to reach certain very tentative conclusions with respect to loss rates for specific items, or kinds of items. These are indicated below, but it is stressed that these are tentative and preliminary judgments, which require further consideration, not only on the basis of the data included in this report, but also in consideration of a substantially larger statistical base.

Signal Equipment Losses

The data obtained in the research for this study was too spotty and unreliable to provide a basis for any generalizations. Nonetheless, the mean value tables do provide a starting point for further investigation.

Rifle Loss Considerations

It is tentatively suggested that actual combat losses for rifles and other individual shoulder weapons will be in the range of 12%, with about two-thirds of this combat.

It appears that actual loss of rifles in front-line infantry units will be about 4% of total casualties, and that combat loss of shoulder weapons among supporting personnel (infantry, artillery, engineers, etc.) will vary from about 1% to 3% of total casualties, depending upon the artillery and air support capability effectiveness of the enemy. Wearout losses will include an additional factor for prolonged duration of combat. On the basis of experience analyzed in this study, it is suggested that these additional factors will be in the nature of about 1% per month, and 1% each per/100 kilometers travelled. The effects of density and other factors should also be applied. Further study is required.

Automatic Weapon Loss Considerations

The figures and loss rates reveal that the relative loss rates of automatic weapons increase in the defensive posture. This is completely consistent with the basic facts of combat tactics and doctrine. Automatic weapons are among the most important targets of attacking mortars and artillery.

It also appears that automatic weapons loss rates do not climb as rapidly as those of some other items of equipment during withdrawal. There is, of course, a considerable absolute increase in the loss rate, reflecting combat damage, loss in haste of evacuation of positions, and abandonment as personnel casualties mount and as ammunition becomes short. But it appears that the actual density of automatic weapons increases, or at least does not decrease, in a unit in a critical withdrawal situation, provided there is sufficient ammunition.

Mortar Loss Considerations

The rate for mortar losses appears to vary quite closely with the rate of loss for automatic weapons, but is affected further by effectiveness of hostile artillery. Where hostile artillery is relatively ineffective, it seems that the mortar loss rates will be about 1/25 that of automatic weapons. Where hostile artillery is very effective, the rate will increase to something like 1/15 of the automatic weapon loss rate.

While mortars apparently do not become so important to the troops in withdrawal as do automatic weapons, it is evident that their loss rate in this posture does not mount so rapidly as some other items.

Artillery Loss Considerations

There is some question whether the figures reported in this study include self-propelled 105mm howitzers, except for the First Army. This question should be resolved if further data is to be developed for this or related studies. Also there is some question as to whether the pack 75mm howitzers, present in some units of the Fifth Army instead of 105s, should not have been included to provide a better representative picture for artillery loss rate comparisons.

Despite these questions, the figures developed, particularly in the mean value tables, provide results which demonstrate the influence of American artillery doctrine on losses, and thus contain internal evidence of reliability.

Vehicle Loss Considerations

One of the principal problems in evaluating vehicle loss rates is the relationship of combat loss to wearout, and the great influence on this latter factor of the age of the vehicles. As is evidenced by the Korean War data, the age of the war is not necessarily an adequate basis on which to judge the probable age of equipment.

On the other hand, the data in this report and its enclosures does suggest that a detailed, independent analysis of losses of different units, giving consideration to all known factors, including distance travelled, anything known about age of equipment at the start of an operation, nature of terrain, etc., could provide a valuable input to the overall RAC study.

General Comments

The Intangibles

In considering a sizable body of experience, the influence of many factors tended to lose significance as larger aggregations of data were made. Climate and terrain have some effect, but over a long campaign the climate varies in most places and the preparation of material for service in extreme conditions has some offsetting effect. The intangibles--leadership, training, etc.--come into play, but again their effect may average out over time. This requires further investigation. In the enclosures there will be found a short narrative account of the 2nd Division's first three weeks in Korea, with emphasis on the situation and experience of the 9th Infantry. This gives a good general account of what might happen in an extreme situation, but the effect of such happenings on long-term loss calculations is not great.

It is probable that, aside from infectious disease, nonbattle casualties will provide a clue to the combat capability of a unit, and will in turn affect equipment loss rates. This also requires further investigation.

World War I Data

It is obvious from the very short consideration given to World War I data in this study, that the intensity of conflict in that war probably provides a basis for ascertaining likely extreme ranges for noncatastrophic personnel and equipment losses. For that reason, considerable more research and evaluation of World War I data is desirable.

Estimates and Actual Losses

As would be expected, there is an almost universal tendency to overstate requirements. If this is done consistently, at high enough levels, the result could be seriously inflated demands on production. This is illustrated in the comparison among the loss rates predicted by the First Army, the actual losses sustained, and the loss rates developed by the War Department (previously furnished). There is further evidence of this tendency in the comparison (previously furnished) between actual losses in the Tenth Army on Okinawa and the equipment arriving in the scheduled convoys. As the experience of the 2nd Division at Kunu-ri attests, there is always the possibility that exceedingly high losses will

be suffered by some units from time to time. As long as such aberrations are averaged into longer range calculations, it is better to provide for such contingencies by adequate flexibility and speed of response in the supply system rather than by "worst case" stock level planning. This can be demonstrated by comparing requirements based on the "high end" loss rates of the units reported on herein with "low end" rates for similar units.

Influence of Shortages

In some categories of equipment--particularly general purpose vehicles--it appears safe to say that shortages breed shortages. It has not been possible in this project to measure this effect, or to put it in balance with the factors of distances travelled and elapsed time. All these elements appear from time to time and reinforce one another. The comparatively greater losses in ¼ ton and 2½ ton trucks in the Fifth and Seventh Armies do seem to indicate the advisability of basing requirements for replacements on the experience of commands operating in similar environments. Comparison of European losses with those sustained in Okinawa supports this concept, although no weight is given to the "age of the war" factor, nor was it possible to develop adequate information on the differences in "age of equipment at beginning of combat" among the several Armies.

Organizational Problems

It was not possible to quantify the effects of organizational and operational factors on loss rates, although a number of citations of general influence of such factors were found. The misuse of service troops in guard and security functions was noted as an impediment to good maintenance and consequently an influence toward earlier wearout or breakdown. The length and nature of the Line of Communications is reflected, as would be expected, in its effect on losses in vehicles. The distribution of effort along the LOC, the location of supply and service installations, and the levels at which replacement stocks were held all had some influence. The record did not yield enough information to support the separate identification and evaluation of the sorts of influences just described, so the only reasonable alternative seems to be the use of replacement requirement factors based on the general, long-term type of experience most likely to be similar to the contingency under consideration.

The Influence of Unit Size and Aggregation

The flaws in the reporting system, with emphasis on those normal to the "fog of war," reduce confidence in the factors derived from short periods of action in smaller units. Confidence increases with time covered and size of aggregate sample, but even here there are notable divergencies in the experience of Armies. Time in posture contributes significant differences, but over the long term it would appear difficult to predict such a factor with any accuracy. The total loss history of armies seems most likely to produce a stable base. In pricing out contingency plans for loss prediction purposes, it would be prudent to use that body of experience most closely similar to those plans.

Relationship of Equipment Losses to Personnel Casualties

The data in this report provides no basis for establishing any meaningful relationship between personnel casualties and equipment losses. Not only are there great divergencies, but there are also too many unquantifiable imponderables affecting both kinds of loss rates. Obviously, in a very general way, it is observable that equipment loss rates, like personnel casualties, are greater in intensive combat than they are in less intensive combat. But this is only a very erratic general tendency, and does not appear to be susceptible of any mathematical formulation.

There is, however, one important result of this study which may permit modification of the above observation. HERO has not had the time nor the funds to undertake an exhaustive application to all of our data of the formulae derived by Dr. Gilfillan. This should be checked, and further action in investigation, or in refining the formulae, or in abandoning the idea of equipment loss-personnel casualty relationship.

Mathematical Formulae for Predicting Materiel Losses

The mathematical formulae derived by Dr. E.S.Gilfillan for this study appear to offer a basis for a fruitful extended investigation. He prepared these formulae for six different items of equipment: ¼ ton trucks, 2½ ton trucks, rifles, carbines, machine guns, and mortars. (For reasons discussed elsewhere in this report, it is possible that some of the data which he used for rifles and carbines reflecting division operations may have been misleading.)

He considered the following variables: intensity of conflict, terrain difficulty, precipitation, temperature, hours of daylight, experience of troops. He has attempted to quantify terrain difficulty, experience, and intensity of conflict, but did not have the benefit of the ICI factor which HERO has developed. On the basis of further evaluation by the HERO staff, it would appear that the following additional factors might have provided further refinement of the formulae: the relative size, characteristics, and quality of the opposing forces; and the length of the operation or campaign (although apparently he has intended to include this in his factor for the intensity of conflict). It would be helpful, also, to try to quantify leadership, but it is believed that this is unrealistic, and its effect is accounted for as far as probably is possible in the experience factor. It would also be useful if movement or distance could be included as a factor, but this probably is also included to the maximum extent possible in the terrain factor.

Records and Reports--The Battlefield Problem

Experience in this project has made it clear that US forces did not have, in World War II and Korea, standard equipment loss reporting systems that envisaged all the uses to which they might later be put. There were variations in format, content, frequency, and accuracy which reflected the views and needs of local commanders, staff officers, and support agencies. The intensity of combat had some influence, but it was often counterbalanced by the energy and activity of ordnance, supply, or general staff officers.

This does not argue that combat commanders should be concerned with the problems of more complex reports. The commander and staff dealing with the immediate demands and concerns of a battle deal with materiel in terms of their mission in that situation. There is a tendency to report losses as necessary to support requirements for desired replacements. Obviously, a crew-served weapon for which there is no crew is an embarrassment; further, the busy staff officers will tend not to spend too much time on reporting items for which he knows there is no replacement available. The net effect of these conditions is to defer reporting of losses and replacement requirements until the unit is prepared to receive and use the items. This is reinforced by the fact that accurate inventories are seldom possible in the heat of combat and must be deferred until better conditions prevail. This condition produces such results as those seen in the spread sheets for the Seventh Army, and to an even greater degree in the spread sheets for the

28th and 45th Divisions. It is obvious that the losses recorded under the heading "Not Engaged--Rest," or in "Defense," were not incurred during that period but were so reported because they became known while the Army was in that posture. It has also been pointed out by a member of the RAC staff that in May 1945 the prospect of moving from the European Theater to the Pacific or to the United States, leaving old equipment on hand in place and re-equipping with new items later, probably motivated units of the Seventh Army to report as lost or worn out much materiel which previously had been considered as serviceable.

Since it would be unfair and unrealistic to levy more reporting requirements on operating commanders in the field, it would be desirable to search for alternatives which would produce the volume of trustworthy data needed to present operational experience in the proper context. In view of the experience now being acquired in Vietnam, it would be useful to insure that loss data were being preserved in the form and volume that would support future efforts to develop methods of loss prediction. It would be useful to organize, under sponsorship of the Department of the Army or DOD, a small team for collecting information from units in the field. Such a team should include persons with logistics, operations analysis, and military history background. Given adequate access and mobility it should be possible to gather loss data on the ground with minimum distraction to operating forces. Properly planned, this sort of activity should be able to collect and organize information on battle losses in the way best suited to the requirements of procurement planners with minimum disturbance to operating forces.

Selection of Factors for Use in Estimating Losses

It has been noted by the RAC staff that the statement of likely future losses and loss rates will come as a result of "pricing out" contingency plans. These plans are likely, in turn, to be somewhat general in their statements of enemy forces, locale, and duration and intensity of combat. Bearing in mind the deficiencies and shortcomings in army-level reports described at various points in this study, it is nevertheless true that they have been shown to have a useful degree of internal consistency, particularly in comparison with lower level reports. Further, differences between armies can be rationalized in terms of their differing circumstances. HERO believes that historical factors can be used as inputs to loss-predicting formulae when the factors chosen are

derived from combat experience resembling most closely the scenario for the conflict reflected in a contingency plan.

Quantifying Ground Combat Factors

HERO is aware of a number of efforts to establish numerical values for the various influences and conditions of ground combat for use in computer-played war games. Experience gained in the process of completing this project has led us to believe that reliable, precise factors for this use cannot be produced without the conditioning effect of historical judgment. The influence of terrain as discussed earlier, for example, must be put in context with a number of other elements which, in sum, are very likely to be unique in any particular situation. This suggests that further examination of the data in hand and the gathering of further material could produce upper, lower, and mean values for the various influences. The historian and the analyst, working together, should then be able to develop computer inputs which would give proper weight to the combinations of circumstances which are unique to every battle.

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